Some biological differences between Muellerianella fairmairei (Perris) and M. brevipennis (Boheman), a pair of sibling species of Delphacidae (Homoptera Auchenorrhyncha)

by

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INTRODUCTION

Sibling species are of interest in biosystematic studies because they are considered to have resulted from fairly recent processes of speciation (Mayr, 1963; Ross, 1974). A detailed analysis of biological differences existing between siblings may give insight into the probable historical path-way of species splitting and may reveal the extent such divergence has reached at the present.

The species-pair *Muellerianella fairmairei* (Perris, 1857) and *M. brevipennis* (Boheman, 1847) appeared to be excellently suited for an analytical approach to this problem. Kontkanen (1953) has already defined them as siblings. Chromosomal pattern, and the structure of eggs, larvae and females of both species are very similar. Males reveal slight, but constant differences in their external genitalia. This paper is a preliminary report on some of my results. A fuller account with statistics will be given later.

A. FIELD OBSERVATIONS

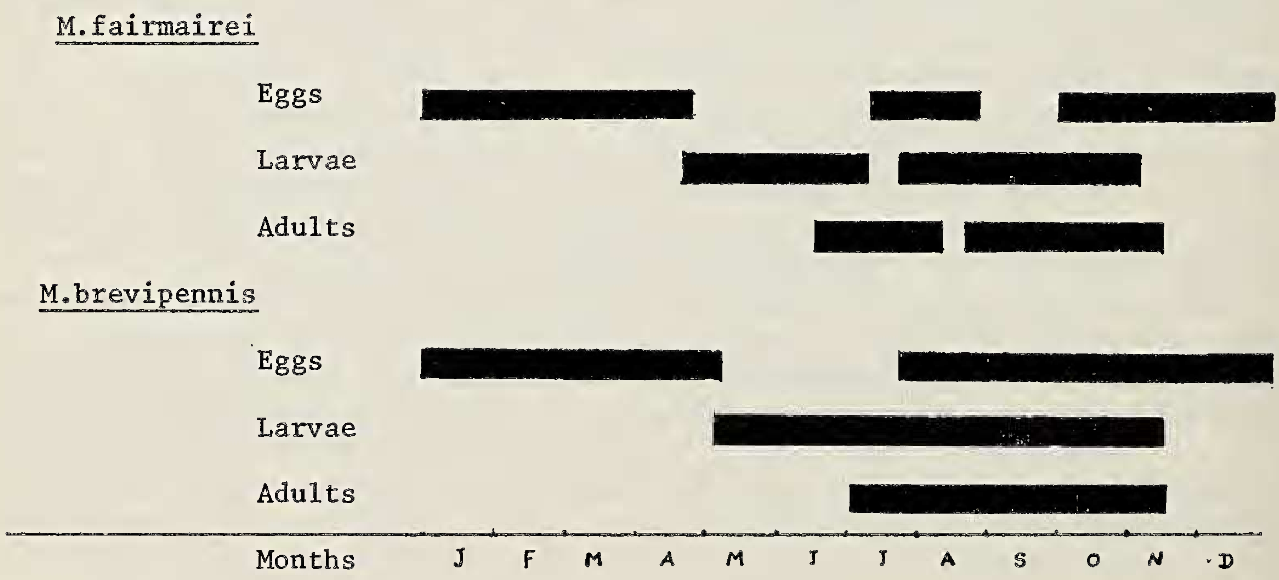
1. Hosts.

In the area of Wageningen (Prov. of Gelderland) and Leersum - Langbroek (Prov. of Utrecht) both species are common, where their respective host plants grow in reasonable numbers. *M. fairmairei* was found only on *Holcus lanatus* (L.) and *M. brevipennis* only on *Deschampsia caespitosa* (L.). In a few localities, where the two hosts are closely intermixed, both delphacids occur syntopically. Hybrids, however, were not found in the field.

2. Phenology.

Both leafhopper species hibernate in the egg stage and are bivoltine. *M. brevipennis* may have an incomplete second generation, because its various stages appear 2-3 weeks later than do those of *M. fairmairei*. However, there is no important seasonal isolation (table 1).

Table 1. Occurrence of M.fairmairei and M.brevipennis of eggs, larvae and adults during 1974 in the area of Leersum-Langbroek.



3. Oviposition sites.

Eggs of first generation *M. fairmairei* are deposited during July in stems of *H. lanatus* (with a mean number of 3 eggs per slit); those of the second generation during September-October in the stems of *Juncus effusus* (L.) (a mean of about 9 eggs per slit). *J. effusus* was used only for oviposition; it appeared entirely unfavourable as a food plant. Winter-eggs were never found in *Rubus* sp. stems which have been reported as oviposition sites for this species in England (Morcos, 1953).

Eggs of *M. brevipennis* of both generations are laid in stems of *D. caespitosa,* with a mean number of 3 eggs per slit.

4. Sex ratio.

M. brevipennis had a 50:50 sex ratio, but the percentage of *M. fairmairei* males varied from 0-25, depending on the area sampled and the sampling method used (sweeping or suction apparatus).

5. Wing dimorphism.

Adults of both species are dimorphic; macropterous or brachypterous. Factors influencing the development of the rarer, long-winged morph, are under study.

6. Parasitism.

Summer and winter eggs of the two species showed up to 40% parasitism by *Anagrus* sp. (Mymaridae). Larvae and adults were never found to be parasitised by other frequent parasites of Delphacidae (e.g. Dorylaidae, Dryinidae or Strepsiptera).

B. LABORATORY EXPERIMENTS

1. Hosts.

Both species were reared as groups in cages (18 × 18 × 48 cm) and plastic cylinders (12 cm in diameter and 60 cm high) or as individuals in glass tubes (7 × 2 cm), at temperatures of 15-28°C and under either long day (L.D. 18:6) or short day (S.D. 10:14) conditions.

M. fairmairei was readily reared in large numbers with no mortality on *H. lanatus. Secale cereale* (L.) and *Triticum aestivum* (L.) were also shown to be acceptable hosts. Rearings on *Hordeum vulgare* (L.) and *Avena sativa* (L.) were less successful, while those on *D. caespitosa* failed entirely. If young seedlings of *D. caespitosa* were offered to first instar larvae, a few females were obtained. These were about 0.5 mm shorter than normal and did not oviposite successfully, even after they had copulated with normal males.

M. brevipennis reared most favourably on *D. caespitosa,* but 100% mortality occurred on *H. lanatus.* Rearings on the cultivated Gramineae mentioned above, resulted in only a few adults.

2. Oviposition.

a. Hosts for oviposition.

a1) Under long day conditions: *M. fairmairei* oviposited only in stems of *H. lanatus,* even when *J. effusus* was present. Eggs were deposited in clusters of 1-6, with an average of about 2.5 eggs per slit.

M. brevipennis oviposited in the stems of *D. caespitosa* in clusters of 1-7 eggs, with an average of 2.3 eggs per slit. Occasionally, eggs were laid in stems of *J. effusus* with a higher average number of eggs per slit.

a2) Under short day conditions: *M. fairmairei* oviposited predominantly in *J. effusus* in clusters of 1-26 eggs with an average of about 9 eggs per slit. Whenever *J. effusus* was not available, eggs were laid in *H. lanatus* in clusters of 1-6 eggs. Short day oviposition in *M. brevipennis* was similar to that of long day conditions.

b. Pre-oviposition period (Long day conditions).

Brachypterous females of *M. fairmairei* had a pre-oviposition period of 5.4 ± 0.90 days; macropterous females 9.9 ± 4.65 days.

c. Duration of oviposition period (Long day conditions).

M. fairmairei continued ovipositing for 35.7 ± 4.3 days. Differences between the two wing morphs were not found.

d. Egg production (Long day conditions).

Brachypterous and macropterous females of both species laid an average of about 330 eggs per female (range 83-564).

e. Egg fertility. Under normal sex ratio conditions, egg fertility in both species appeared to be near 100%.

Comparative experiments of b and c with *M. brevipennis* are not yet finished, but there are indications that pre-oviposition and oviposition periods may be longer.

3. Egg diapause.

Witsack (1971) has studied embryonic dormancy and the factors inducing it in *M. brevipennis* from East Germany. Müller (1972) has proposed the term "oligopause" for both species in which dormancy begins and ends gradually, and is induced by the same environmental factor (photoperiod).

The data of Witsack appear to apply also to Dutch populations of *M. brevipennis*. Thus, under long day conditions (L.D. = 18:6) and at temperatures of about + 20°C, the embryos of both species develop without interruption. Under short day conditions (L.D. = 10:14) and the same temperature, embryogenesis is inhibited before the embryo rotates. In all cases, eggs with rotated embryos hatched after 7-12 days.

However, some important differences are found between the diapause of these species: a. All eggs of *M. brevipennis* deposited under short day conditions, had a strong diapause, but about 5% of the eggs *M. fairmairei* produced under the same conditions, developed continuously. Adults developing from these eggs, laid up to 75% non-diapause eggs under the same conditions. Therefore, *M. fairmairei* can be reared without interruption under short day conditions. b. Diapause is terminated in 50% of the eggs of *M. fairmairei*, after 3 weeks of cold treatment (3°C), but to obtain the same results in *M. brevipennis*, 7 weeks are required.

4. Larval development

Under long day conditions and at temperatures of 20-25°C, larvae of both species develop at the same rate (table 2).

Under short day conditions (L.D. = 8:16) and temperatures of + 20-25°C the last instar of *M. fairmairei* larvae requires a significantly longer time of development (table 3). For *M. brevipennis* such data are not yet available.

Table 2. Larval development in days of M.fairmairei and M.brevipennis at 20-25°C and 18:6 day length.

Number of individuals		instars I	II	III	IV	V	total development
M.f.	60	4.75±0.70	3.44±0.50	3.40±0.55	4.00±0.35	5.33±0.67	21.0±1.2
M.b.	53	4.70±0.35	3.43±0.80	3.25±0.45	4.00±0.70	5.22±0.80	20.5±2.0

Table 3. Larval development in days of M.fairmairei; at 20-25°C and 8:16 day length.

Number of individuals	instars I	II	III	IV	V	total development
30	4.70±0.40	3.49±0.61	3.31±0.57	4.03±0.91	7.50±1.48	23.2±2.8

5. Sex ratio

M. fairmairei reared continuously on *H. lanatus* under both short and long day conditions, at any temperature between 15-28°C, produced 95-100% females. We have some indication, that *H. lanatus* plays a role in the determination of its ultimate sex ratio (see under section 6).

M. brevipennis maintains its 50:50 sex ratio when reared under the same conditions.

6. Wing dimorphism

First-instar larvae of both species reared in groups of 1-5 in glass tubes under long day conditions and at temperatures of 15-25°C always developed into brachypterous adults. Dense populations of first-instars of both species (n>100) reared in cages resulted in the appearance of macropterous forms in varying percentages. Under short day conditions single or 'mass' rearings never resulted in macropterous forms.

7. Crossings

Unmated females of *M. fairmairei* placed in cages containing *H. lanatus* and *D. caespitosa* with males of *M. brevipennis* ultimately produced hybrid females and a few hybrid males. The reciprocal cross (*i.e. M. brevipennis* ♀♀ and *M. fairmairei* ♂♂) had similar results.

All male hybrids were sterile. Degenerated testes and absence of spermatogenesis were obvious, although the male hybrids were observed to copulate with female hybrids and with females of both parental species.

Female hybrids were fertile and were back-crossed with males of both parent species, so that F_2 and F_3 generations were obtained — so far, however, without any male offspring appearing.

Hybrids of F^1's and both back-crossing generations developed on both hosts, *H. lanatus* and *D. caespitosa. H. lanatus* may determine the low percentage of males in *M. fairmairei,* because some crossings between 6 females of *M. brevipennis* with 6 males of *M. fairmairei* on *D. caespitosa* resulted to 11 males and 12 females, whereas the same crossing on *H. lanatus* resulted in up to 25 females only.

8. Courtship and mating behaviour

Preliminary observations have already shown differences to exist between both species and their hybrids. This part of the study will be worked out in greater detail, since such behaviour provides one of the crucial isolating mechanisms existing between closely related species.

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REFERENCES CITED

Kontkanen, P. 1953. On the sibling species in the leafhopper fauna of Finland (Hom. Auchenorryncha). *Arch. Soc. Vanamo,* 7: 100-106.

Mayr, E. 1963. *Animal species and evolution.* Belknap Press of Harvard University Press, Cambridge, Mass., 797 pp.

Morcos, G. 1953. The biology of some Hemiptera-Homoptera (Auchenorryncha). *Bull. Soc. Fouad 1er Entom.* 37: 405-439.

Müller, H. J. 1972. Dormanzformen der Zikaden und ihre ökologische Bedeutung. *Tag. Ber. Akad. Landwirtsch.-Wiss. DDR.* nr. 121: 81-90.

Ross, H. H. 1974. *Biological systematics.* Addison-Wesley Publishing Company, (Inc.) 345 pp.

Witsack, W. 1971. Experimentell-ökologische Untersuchungen über Dormanz-Formen von Zikaden (Homoptera-Auchenorryncha). I. Zur Form und Induction der Embryonaldormanz von Muellerianella brevipennis (Boheman) (Delphacidae). *Zool. Jb. Syst.* 98: 316-340.